SolarMetrics

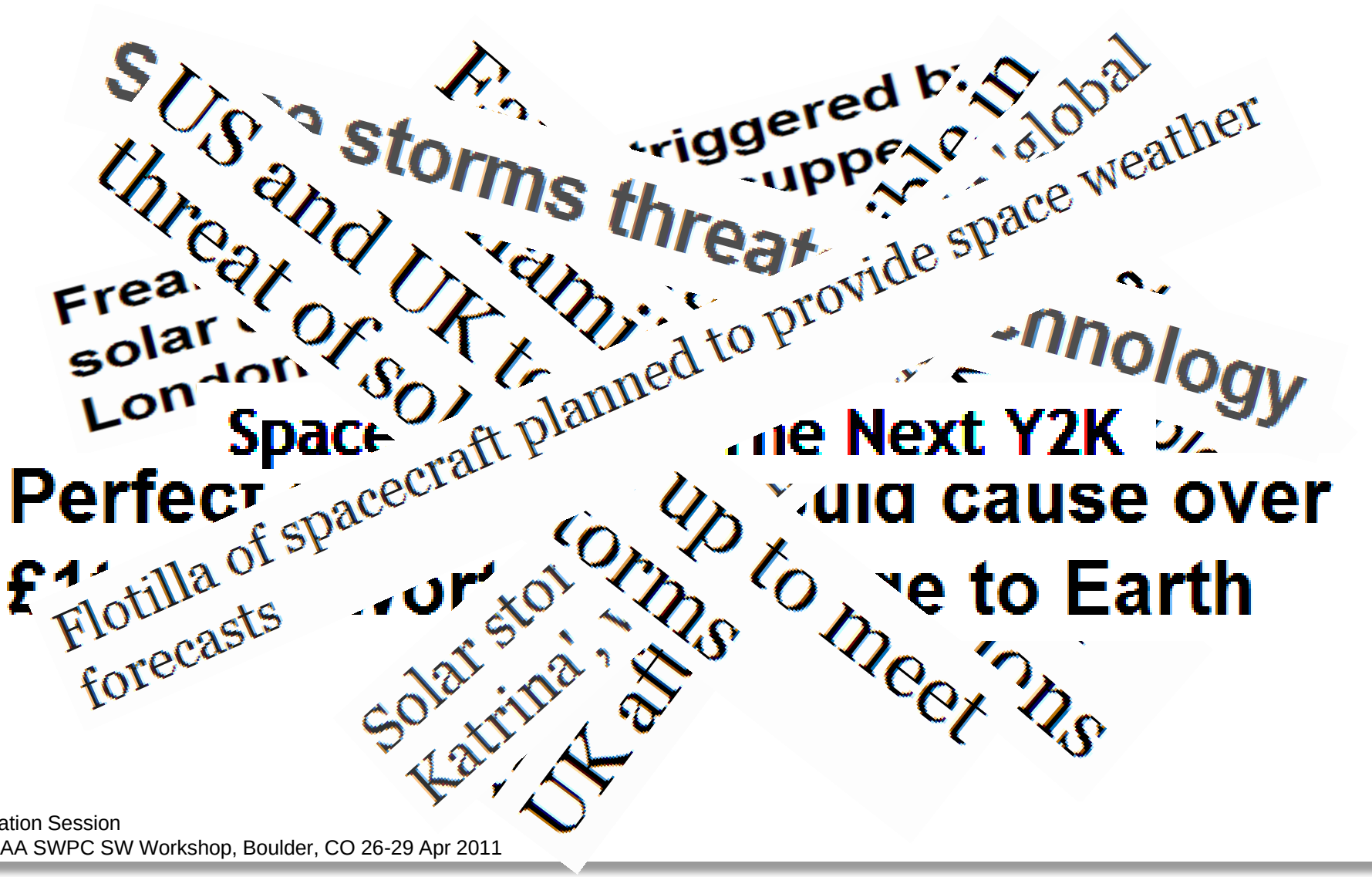
Planes, Trains, Automobiles:
Efforts to Mitigate the Super Storm

Captain Bryn Jones
bryn.jones@solarmetrics.com

Dr David Boteler (NRCAN)
Prof Paul Cannon (QinetiQ)
Prof Clive Dyer (QinetiQ)
Dr Genene Fisher (AMS)
Prof Mike Hapgood (RAL Space)
Prof Richard Horne (BAS)
Dr David Kerridge (BGS)
Joseph Kunches (NOAA SWPC)
William Murtagh (NOAA SWPC)
Dr Keith Ryden (QinetiQ)
Mike Stills (United Air Lines)

Aviation Session
NOAA SWPC SW Workshop, Boulder, CO 26-29 Apr 2011

Some UK headlines 2010-11



Outline

- Aviation User Service Needs
  - Background to Requirements
  - Cross Polar Working Group
- UK Space Weather Activities
  - Government – Infrastructure risks
  - Resilience & Mitigation – Worse case scenario

Aviation User Service Needs - Background to Requirements

2000: EU Directive for Aircrew occupational exposure

2000: Polar routes begin

2002: US SEC Aviation Workshop, ESA funds study

2003: Geo storm renders WAAS unavailable

2004: Avionics IEC TS 62396 drafted

2005: $12M/yr additional fuel costs

2005-08: AMS/SolarMetrics US policy study – FAA, NextGen

2006: Solar radio bursts affect GNSS

2008-10: CPWG - User Service Needs

2009-14: FAA, ICAO (IAVWOPSG), WMO

User Service Needs: Fundamental Needs

AUN-1 Define the impacts of space weather

AUN-2 Provide 3 types of information: Observations, Forecasts, and Climatology

AUN-3 Provide information in text and graphical format

AUN-4 Present information using standardized format and content

AUN-5 Describe the severity of impact in standardized text and graphical reports

AUN-6 Provide text and graphical reports using specified timelines and durations

AUN-7 Provide an estimate of the accuracy of the information

AUN-8 State the regions affected

AUN-9 Utilize stated transmission methods for space weather reports

User Service Needs: Specific Operational Needs

AUN-10 Provide information on disruptions to HF communications

AUN-11 Provide information on disruptions to VHF communications

AUN-12 Provide information on disruptions to UHF communications

AUN-13 Provide information on disruptions to Satcom

AUN-14 Provide information on the radiation environment that will affect avionics

AUN-15 Provide information on the radiation environment that will affect humans

AUN-16 Provide Information on the accuracy and availability that will affect GNSS

User Service Needs: Supplementary Needs

AUN-17 Define space weather information & decision-maker matrices

AUN-18 Define communication and integration of space weather information

AUN-19 Provide space weather education and training

AUN-20 Use global standards for space weather information

User Service Needs: Public Release

COMING SOON!!

bryn.jones@solarmetrics.com

FAA Aviation Weather Group tasked:

- develop requirements to be provided to ICAO
- created Space Weather Team
- timeline through 2014+ developed

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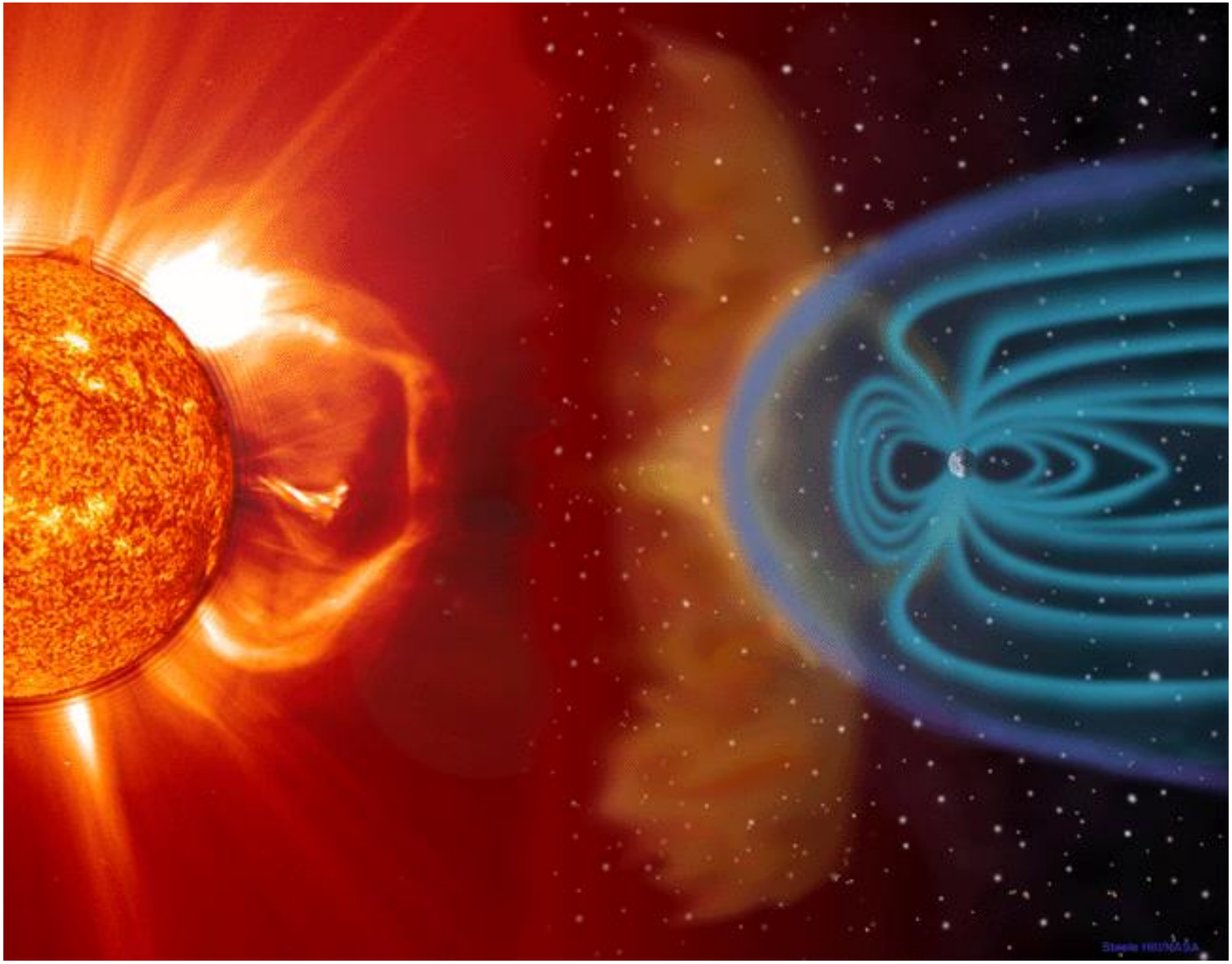
UK Space Weather Activities



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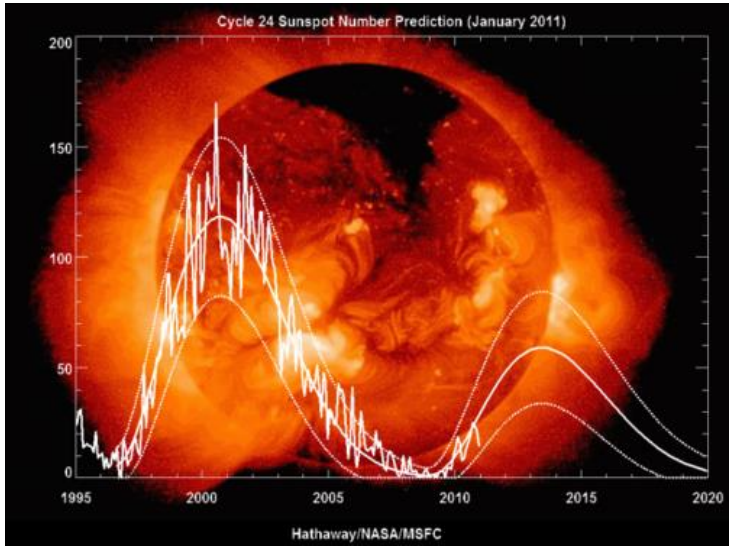
UK Space Weather Activities = Interdependency, Resilience, Mitigation

UK Space Weather Activities

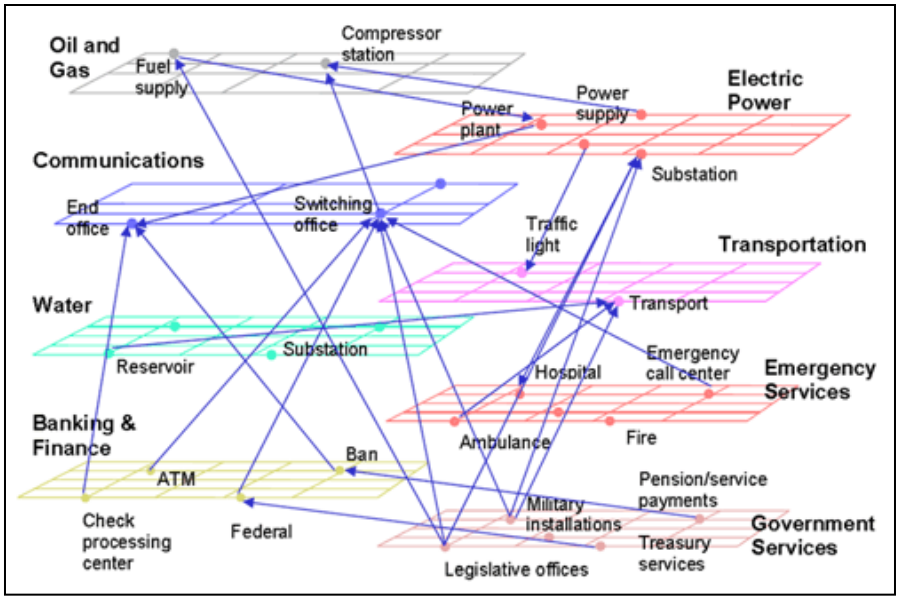


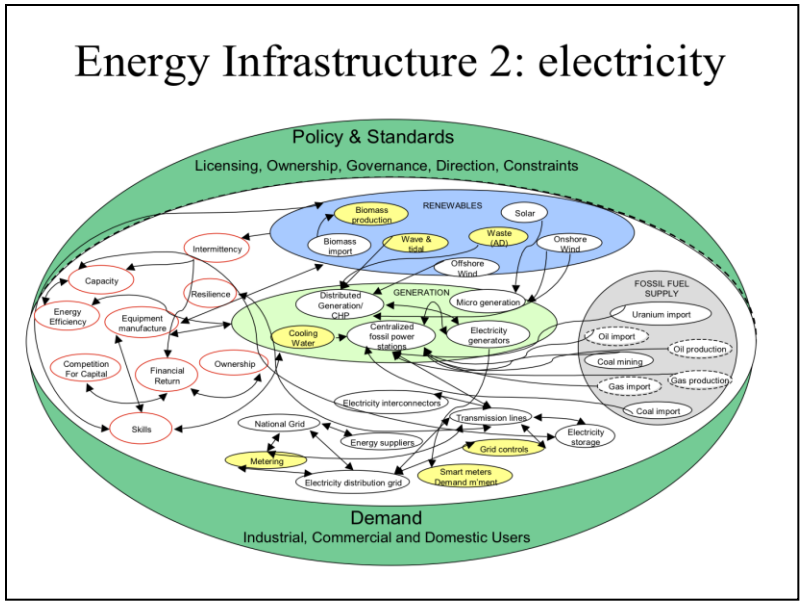
Drivers?

- Parliamentary Questions
- Solar Maximum
- Possible under-estimation of threat
- Data availability
- Increased societal dependence on technology

Critical Infrastructure

Interdependency

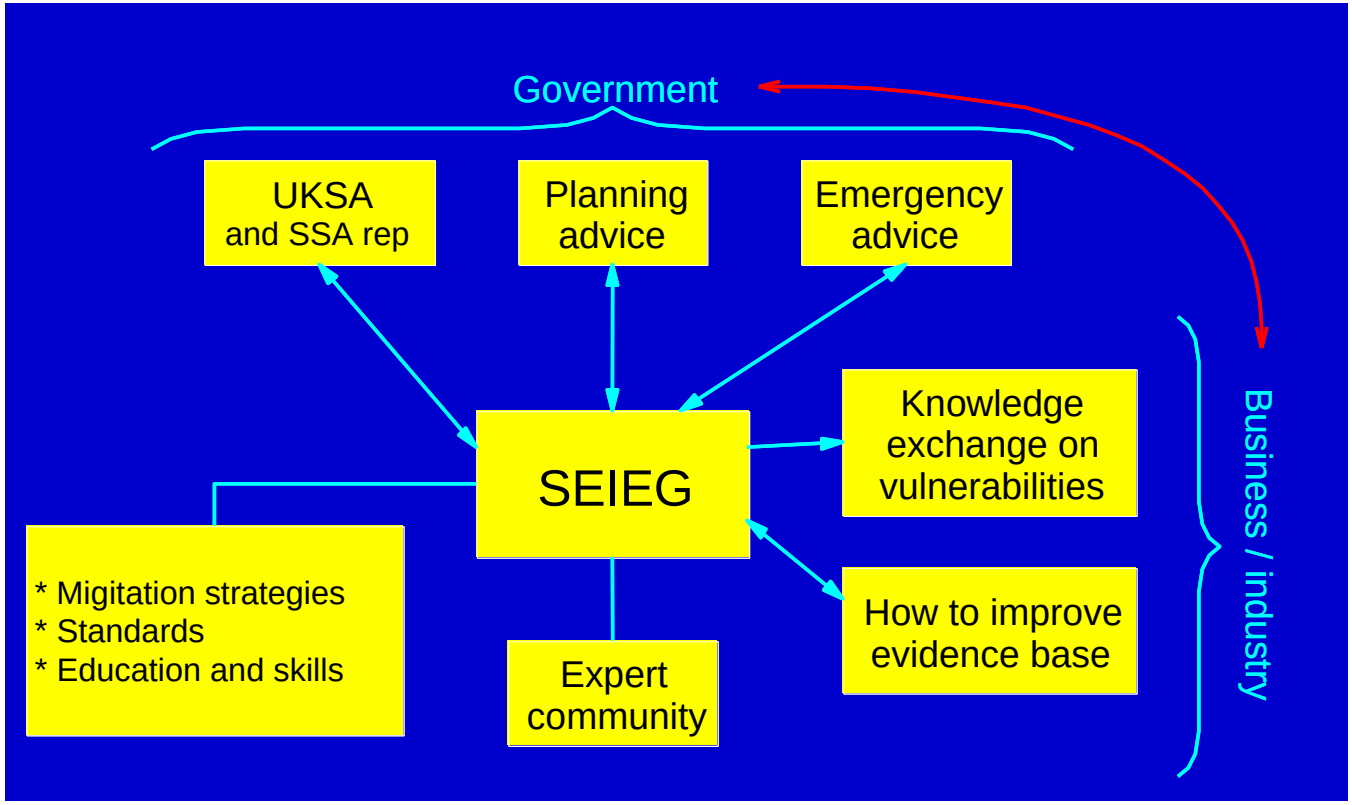




Resilience?

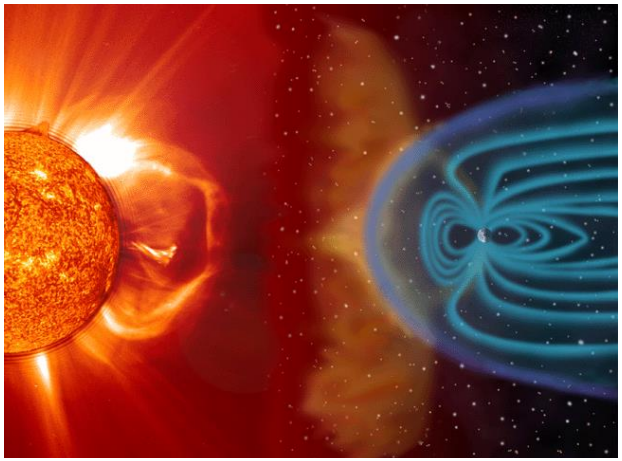
Worst Case Scenario?

Space Environment Impact Expert Group (SEIEG)



- Experts: radio, geomagnetic, particle & thermosphere
- Government: CCS, GO Science, MOD, UKSA + others
- Can feed into SAGE system

UK Space Weather Activities - Mitigation



UK SPACE AGENCY

NATURAL ENVIRONMENT RESEARCH COUNCIL

Government Office for Science

Any words All words Exact phrase

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Space weather

Sir John Beddington has coauthored an article in the New York Times with President Obama's science advisor, John P. Holdren. The article discusses potential risks from space weather, which can affect human safety and economies anywhere on our vast wired planet, and remedies for dealing with those risks.

1 Japan nuclear incident | 2 Space weather | 3 Scepticism and consensus

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COUNCIL FOR SCIENCE AND TECHNOLOGY

The Government Chief Scientific Adviser

Professor Sir John Beddington CMG FRS is the Government Chief Scientific Adviser responsible for the quality of all engineering and scientific advice across Government, reporting directly to the PM and the Cabinet Secretary.

Biography

Speeches

Interviews and articles

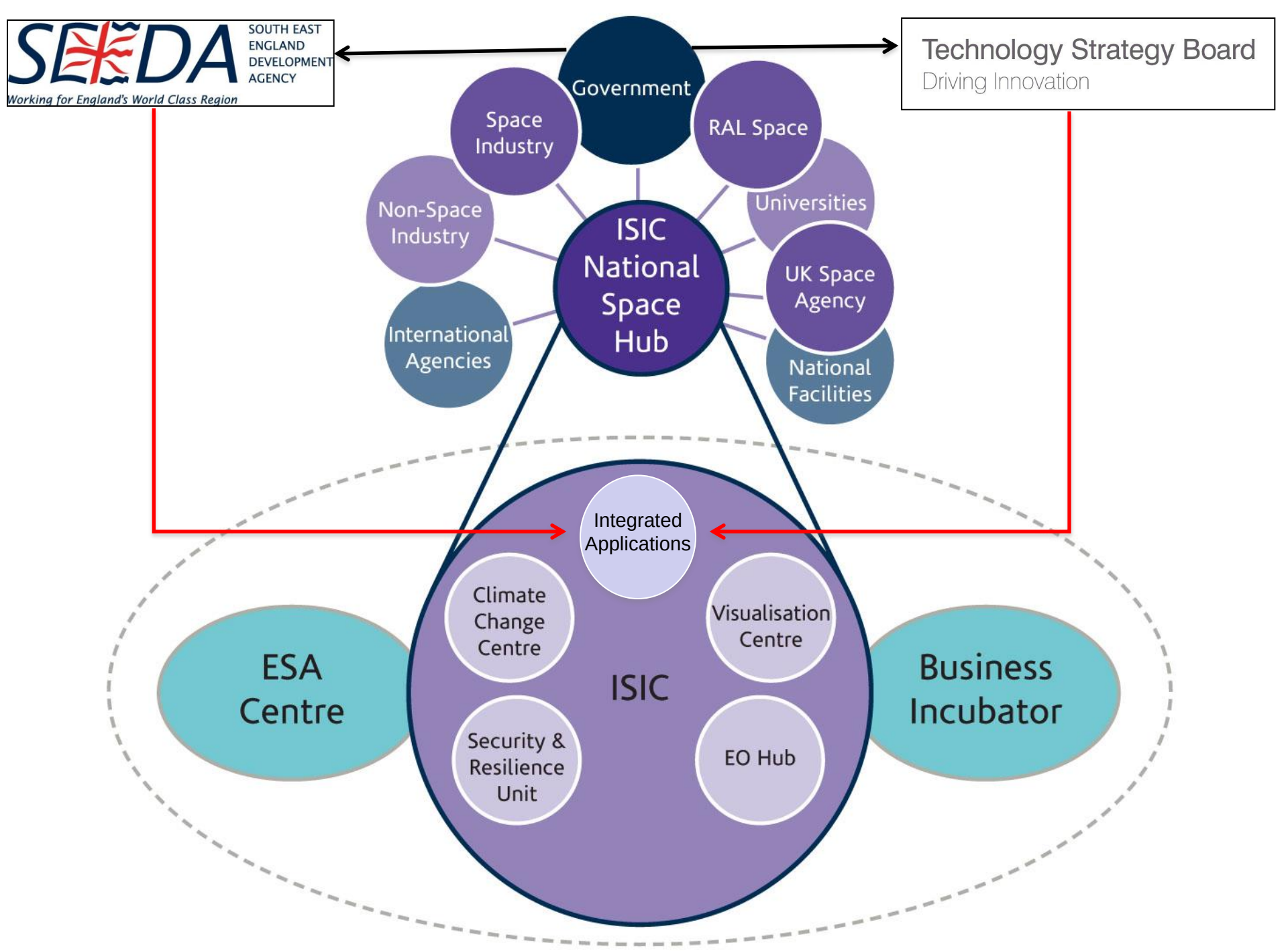
Follow us on Twitter

Follow Sir John Beddington's office on Twitter

STFC International Space Innovation Centre

Met Office

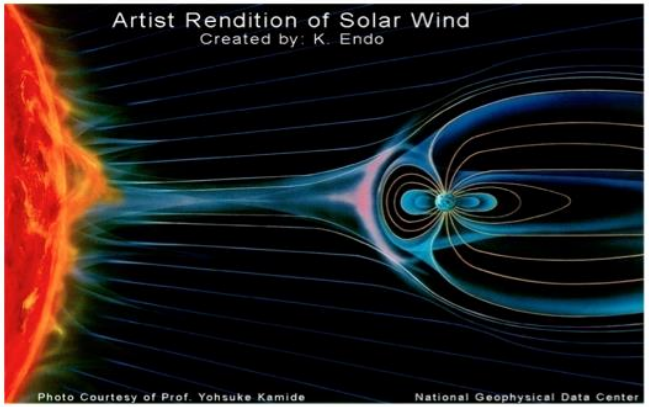
NOAA


SEEDA
SOUTH EAST ENGLAND DEVELOPMENT AGENCY
Working for England's World Class Region
Technology Strategy Board
Driving Innovation
Government
Space Industry
RAL Space
Universities
Non-Space Industry
ISIC National Space Hub
UK Space Agency
International Agencies
National Facilities
Integrated Applications
Climate Change Centre
Visualisation Centre
ESA Centre
ISIC
Business Incubator
Security & Resilience Unit
EO Hub

ESA SSA

SPACECAST

Protecting space assets from high energy particles by developing European dynamic modelling and forecasting capabilities



Richard B Horne
Hannu Koskinen, Natalia Ganjushkina, Daniel Boscher,
Blai Sanahuja, Stefaan Poedts, Carla Jacobs,
and Daniel Heynderickx

British Antarctic Survey
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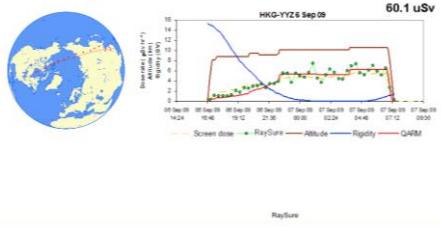
UK Space Weather Activities – Data Availability

QinetiQ on-board aircraft radiation monitor

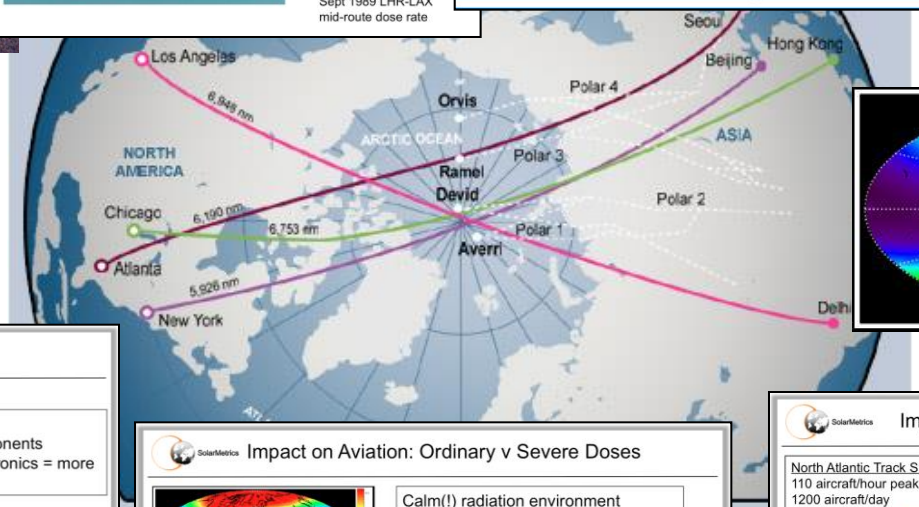
RaySure ®
Biological dose screen readout and alarm
Internal data store
Battery powered (NiMH)
Currently 4 units deployed on aircraft worldwide
Screen represents Sept 1989 LHR-LAX mid-route dose rate

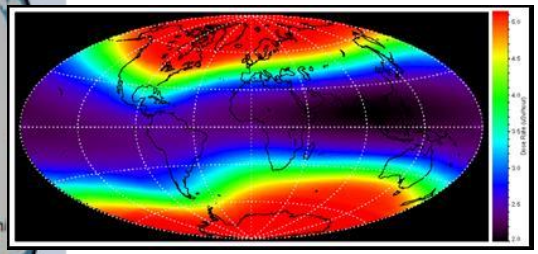
Toronto to Hong Kong



Upset Rates in 1 Gbyte of SRAM
(Cross-Section of 5×10^{-14} cm^2 per bit)

Event	Neutron Flux /(cm^2-sec)	Upset Rate (/hr)	MTBU (sec)
1GV - 17km			
23-Feb-56	2893	1164	3.1
29-Sep-89	487	196	18.4
19-Oct-89	39.1	15.7	229
22-Oct-89	70.4	28.3	127
24-Oct-89	79.7	32.1	112
GCR (Sol. Max)	9.3	3.6	1003
1GV - 12km			
23-Feb-56	1113	493	7.3
29-Sep-89	191	84.7	42.5
19-Oct-89	16.1	7.1	504
22-Oct-89	28.2	12.5	288
24-Oct-89	31.5	13.9	258
GCR (Sol. Max)	5.8	2.5	1468

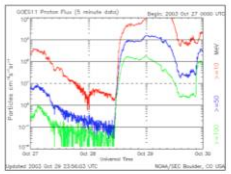




Impact on Aviation: Avionics

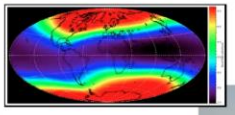
Avionic upsets, failures
- Fewer radhard components
- More advanced electronics = more susceptibility

Upset rate/hr in memory chip (avg 2.5/hr)
(Dyer et al)
- Sep 1989 – 84.7/hr
- Feb 1956 – 493/hr
- Sep 1859 – ?



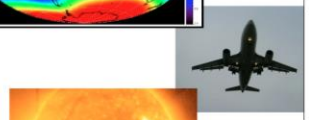
Impact on Aviation: Severe Space Weather and EMP
EIS Summit, Westminster Hall, London, 20th Sep 2010

Impact on Aviation: Ordinary v Severe Doses



Calm(!) radiation environment
London – Los Angeles 0.065mSv

Solar Storm Doses (Dyer et al.)
Jul 2000 – 0.031mSv
Oct 1989 – 0.25mSv
Sep1989 – 1.33mSv
Feb 1956 – 2.27mSv
Sep1859 – ?



Impact on Aviation: Severe Space Weather and EMP
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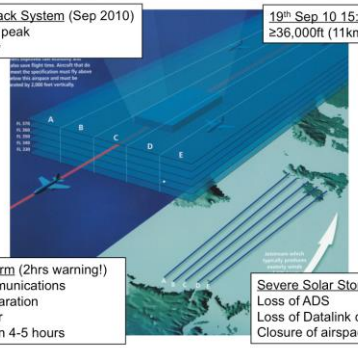
Impact on Aviation: Operations, Safety

North Atlantic Track System (Sep 2010)
110 aircraft/hour peak
1200 aircraft/day

19th Sep 10 15:30
≥36,000ft (11km) - 41 aircraft



Strong Solar Storm (2hrs warning!)
Loss of HF communications
Double time separation
~ 40 aircraft/hour
Severe disruption 4-5 hours

Severe Solar Storm
Loss of ADS
Loss of Datalink communications
Closure of airspace

Impact on Aviation: Severe Space Weather and EMP
EIS Summit, Westminster Hall, London, 20th Sep 2010

Summary

- Aviation Space Weather User Service Needs – Coming Soon

UK Space Weather Activities

- Infrastructure resilience & mitigation undertaken
- National space policy inclusive of Space Weather programme
- Government, MOD, Academia & Industry
- Investing in UK Space Weather